HISTORY and DEVELOPMENT of the American Steam Locomotive.

By
R. H. Brown, '98.

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In this brief history of the development of the locomotive, only a few of the most important points can be considered.

Two hundred years ago, a harmless vapor arose with the morning sun, and floated away unheeded by all, except perhaps, the artist and poet. How is it today? From myriads of towering columns, o'er which the fierce fire-king flings his mantle, gushes in mimic clouds the quick breath of our new born Titan.

The first steam engine of which we have any knowledge in America was at Schuyler copper mines in Passaic, N.J. It was more properly speaking an atmospheric engine and was imported from England in 1736.

The first engine constructed in America was built by Christopher Colles, in 1772. It was similar to the one which was imported, but was, however, very defective.

Thus it will be seen that it was less than a hundred years from the time America took her first lesson in a science that was destined to work a revolution in the whole world, before she was a leader.

In 1787, Jno. Fitch built the first condensing engine, and this without the help of Watts' experiments, Then came Fulton, and the improvements of Stevens, and Olivar Evans, the first to apply high-pressure engines to common use, and show its advantages not only to stationary, but portable engines, from which we may date the invention of the locomotive engine, for it was only the experience of Stevenson in tram-roads that led him at a later day to the invention of the latter; and Watts' engines could never have been used on account of their great size.

Engines were first applied to common road carriages. Then the introduction of railways turned the attention of mechanics to them, and steam-carriages were abandoned.

The first railway built in the United States was from Milton to Quincy, Mass. a distance of two miles, in 1826. The Baltimore and Ohio, was the first passenger railroad, and was opened in 1830, a distance of 15 miles, with horse-power.

The first locomotive upon a railway

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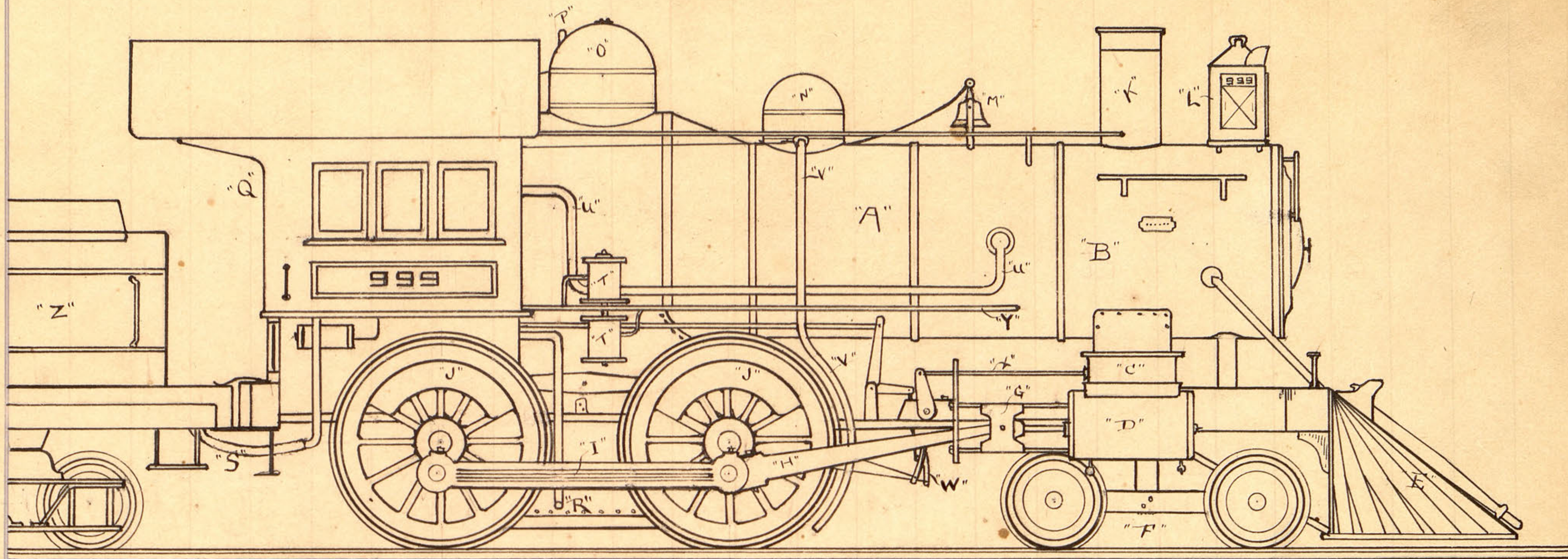
Model Locomotive.... built by R.H. Brown, 1897 in college shop.



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Scale, 1½ inch to 1 foot.

Designed and Built by R.H.Brown, '98.

c 1897.

A. Boiler
B. Smoke-box
C. Steamchest
D. Cylinder
E. Pilot
F. Front truck
G. Chr head & guides
H. Mainrod
I. Connecting, or parellel rod
J. Driving wheels
K. Smoke stack
L. Headlight
M. Bell
N. Sandbox
O. Steam dome
P. Whistle
Q. Cab
R. Fire box
S. Suctionpipe for injector
T. air pump
U. Injector pipe
V. Sand pipe
W. Links, and valve motion
X. Valvestem.
Y. Running board.
Z. Tender, or Tank.

in this country, was built at Stourbridge, Eng., called "Stourbridge Lion", and imported by a Mr. Allen.

The first locomotive built in this country was built by Peter Cooper, in 1829. It was a small crude affair, the boiler not as large as a kitchen boiler attached to many a range in modern houses of today. It could run 15 miles per hour on slight down grade.

The second engine, and the first built for actual service was the "Best Friend" built at West Point Foundry, New York, in 1830. The wheels were made with iron hubs, wooden spokes and fellows with iron tires. It had a successful run, until one day the negro fireman, becoming tired of hearing the noise of escaping steam, put his weight on the safty-valve, and exploded the boiler, killing the fireman and scalding the engineer, thus we have in the "Best Friend" the first locomotive built for use, and the first locomotive boiler explosion on record.

The third locomotive was called "West Point" built in 1830, by West Point Foundry. It was about the same as "Best Friend" only that it had a horizontal <u>tubular</u> boiler, instead of a vertical one. The working of this engine in actual service was very satisfactory.

The fourth engine was the "DeWitt Clinton", built in 1831. Its cylinders were 15½ inches in diameter and 16 inch stroke, the four wheels were connected; they had cast-iron hubs and wrought iron spokes. This engine weighed nearly four tons, and could run about 30 miles an hour on level road. It used anthracite coal.

In 1832, several engines were built for the Baltimore and Ohio Railroad. In Nov. 1832, Mr Baldwin, (founder of the Baldwin Locomotive works) built a locomotive called "Old Ironsides" which did good service for 20 years. This engine was the last copy of English Engines.

In 1834, Mr. Baldwin built another engine for a South Carolina Railroad. This engine was six wheeled, cylinders 10"x 16". His boiler also had a high dome over the firebox, which has been improved, but never changed, even up to date.

By this time, several builders entered the field, each improving the then existing types, until we have the American locomotive of today;— one of the most perfect pieces of mechanism wrought by the hand and mind of man.

Mr. Baldwin now introduced outside cylinders and connected engine, doing away with crank axle, and placing the machinery where the engineer could see it.

It would be tedious to follow the construction and alterations of various locomotives. We will, however, mention a few most important improvments. —

The truck frame in front of the engine, used in 1832 The four eccentrics, patented by S. H. Long, in 1830, and first used in 1833.

The Rogers works began in 1837. This shop made several material improvments: enlarged the boiler in proportion to the cylinders, established link-motion, and covered the steamchest and cylinder to prevent radiation. They were the first to adopt the full stroke pump.

Coal rapidly superseded wood as fuel for engines; while it is true that some of the first engines were coal burners, yet wood had been the principle fuel for years.

The American engine has several marked

distinctions from the English. What strikes the eye of the observer the most is the cab, or house for protection of the enginemen. This is peculiar to our locomotives. We have our driving wheels on outside of the frame and each set is arranged seperatly from the others. The English engines, are encased by the frame-work, and all bearings fastened to this frame. An English engine could not run 20 miles per hour with safty on our tracks, on account of its rigidity. A common criticism is that the American engine is too loose-jointed, so to speak; but there is not an engine in the world that excells it, and put one of our best express engines on the English tracks, and we can show them some speed. As it is, we started out with engines that could run from 15 to 18 miles per hour, and have gradually developed to ones that make from 100 to 112½ miles per hour, and regularly haul trains from 70 to 80 miles per hour. However, 40 miles, is about the average. This is accounted for by poor road-bed, and not enough tracks.

Now that we have traced the first locomotive down to modern ones, a few points on the the construction of the modern locomotive, may be interesting.

A locomotive must combine within itself, the means for generating steam, its application to produce motion within the engine, and also the propulsion of the whole upon the road.

A complete engine then, combines three distinct arrangements for realizing these conditions.

The source of power is Boiler and firebox. The means to produce motion within itself, are,- the cylinders, valves, pistons and various connections; and the tractive force, by the adhesion of the wheels, secure the motion. The surplus power is used to draw great loads upon the rails.

The engine consists of a frame; and boiler, cylinders, driving wheel axle boxes, and forward truck which are securely fastened to it.

The driving wheels are placed under the back half of the frame with their axles placed in the axle-boxes, these wheels are connected by main rod to the crosshead, and that to the piston, and so motion produced in the cylinder, on the piston is transmitted to the driving wheels.

A rough drawing will show the position of the parts, much better than a large number of words, so on the next page is an illustration taken from a model locomotive, made by myself, in the shops, last year. It is one seventh of a full size locomotive, but as the figures may be omitted it will answer as well as if drawn from a large one.

The steam is produced in a boiler "A", cylindrical in shape with a rectangular firebox at one end, surrounded by a water casing to prevent the destruction of plates from hot fire. A large number of tubes convey the heated air and gases, and products of combustion, through the boiler to smoke-box "B". These tubes are small and thin so as to give off the heat rapidly to the surrounding water. The surface of the firebox and the tubes, constitute the heating surface of the boiler.

From the smokebox, these gases, etc, escape to the open air through the smoke stack "K", the draught of the fire is produced artificially by the exhaust steam going up the chimney. the stack is smaller in diameter than the cylinder, and when a cylinderful of steam is exhausted it more than fills the stack and as it has considerable force yet, it pushes all of the smoke out of the stack and also creates a vacuum behind it and draws more smoke up the stack, and the next exhaust acts the same way, and so on, so that, when running fast there is a powerful draught produced.

The second division of the arrangment of the engine is that where the power is applied to produce motion within the engine itself.

On top of the boiler at the back end is the steam dome "O". In this is a large pipe, which conveys the steam to the cylinders. Its mouth is placed in the dome so as to raise it as high from water level as possible also that it may be over the firebox to get the dryest steam. The throttle valve is placed on mouth of this pipe, and is connected by a rod to the throttle lever which is in easy reach of the engineer.

Within the smokebox, this pipe divides into two branches, each end going to a steamchest. This steamchest communicates with the cylinder by means of openings called ports, and steam is alternatly admitted to each end by means of the slide-valve. When the steam is in the cylinder, it exerts its force upon a moveable piston, and after the piston has moved the length of the cylinder, the used steam is allowed to escape, and is called exhaust steam. The mouth of the nozzle for exhaust steam is contracted somewhat, and this forms a powerful blast. In this short history, the theory, construction and working of the valve gear cannot be discussed, as this in itself would require a long and complicated article.

Let us now see how the motion given to the piston is transmitted to the driving wheels, thus propelling the machine. Within the centre of the piston, is the "piston rod", which is fastened to a crosshead, which slides back and forth in the guides. This insures the piston moving in the line of the axis of the cylinder. To this crosshead is fastened the "connecting-rod" and this connects with the crank-pin of the driving wheel. As there are two cylinders and two connecting rods, the pins are set at right angles to each other, so that when one side is on "dead centre" the other side is exerting the most force, and thus pulls the wheels over this point.

The motion of the slide valves is derived from eccentrics. there are four of them on forward set of driving wheels, between the wheels.

There are two eccentrics to each valve, one placed so as to give forward motion to the engine, and the other a backward motion. These are encircled by eccentric-straps, and to these are fastened a rod, and these rods are joined by a link, Two eccentrics to a link. These two links can be raised or lowered by a lever in the cab, called "reverse lever", it works as follows:- When the links are down, the goahead eccentrics are brought in a line with the valve stem, and the valve is operated by that eccentric, but if the links are raised the valve is operated by the backing eccentric, and thus the engine can be made to go backward or forward at will.

It can easily be seen that there must be a neutral point between full gear forward and full gear backward, and so there is, called "Centre". This is when the centre of link is in a line with valve stem, so that neither eccentric has any effect on the valve. This is useful in case of a mishap to the throttle valve.

It is now easy to trace the operation of steam and the machinery put in motion by its action on the piston.

The remaining parts of the engine are the rear pair of drivers coupled to forward pair. The only object of these is to obtain greater adhesion to the rails and help share the weight.

The bell and whistle are for signals; the headlight, to illumine the track ahead at night; the sandbox and pipe, to put sand on the rails when slippery; the running board is to enable the engine men to get to front of thea engine while it is in motion; the injector is used in place of a pump to fill the boiler with water raised to certain degree of temperature.

The average American locomotive has a maximum life of about 30 years.

The annual cost of repairs is 10 to 15 per cent of first cost. Each engine requires one quart of oil and about one ton of coal for every 50 miles run.

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